The uptake and diffusion of solar power in Africa: Socio-cultural and political insights on a rapidly emerging socio-technical transition

Ockwell, David; Byrne, Rob; Hansen, Ulrich Elmer; Haselip, James; Nygaard, Ivan

Published in:
Energy Research and Social Science

Link to article, DOI:
10.1016/j.erss.2018.04.033

Publication date:
2018

Document Version
Peer reviewed version

The uptake and diffusion of solar power in Africa: socio-cultural and political insights on a rapidly emerging socio-technical transition

Abstract

In recent years, we have witnessed a rapid market-driven growth in solar PV technology uptake and diffusion, across various geographies and scales in Africa. In this introduction paper we position the contributions to the special issue in the context of the wider literature on sustainable energy access and summarises the contributions of the papers herein, all of which focus on various aspects of the 'solar transition' in Africa. Engaging empirically with the rapidly evolving socio-technical transition that is taking place around solar PV in Africa, we argue that there is an urgent need for greater attention to the neglected socio-cultural and political dimensions of sustainable energy access, dimensions that are vital to understand if ambitious global SDG commitments to achieving sustainable energy for all (ever, let alone by 2030) are to be achieved. This special issue includes papers on the: systemic and socio-technical nature of energy access transitions; politics and political economy of energy access; gendered dimensions of energy access; critical STS perspectives on the dominant, technologically determinist framing of energy access and implications for marginalising local actors, and; (for the first time in the energy access literature), application of social practice perspectives on energy access. The result is a diverse range of empirically grounded, theoretically and methodologically novel (in relation to the existing literature) approaches, providing important new insights into how to understand the neglected socio-cultural and political dimensions of sustainable energy access, whilst simultaneously increasing our understanding thereof.

1. Introduction

1.1 billion people lack access to electricity [1] – a vital pre-cursor of multiple aspects of human development and economic growth [2]. In Africa, this issue is more acute than on any other continent, with only around 43% of those in sub-Saharan Africa (SSA) able to access electricity [1]. Despite a global policy consensus, however, we are not on target to meet international commitments to provide "sustainable energy for all" (SE4All) by 2030 [3], a fact confirmed during a review of progress towards SDG7 by the UN High-Level Political Forum in 2018. There is therefore an urgent need for new thinking on how global efforts can be accelerated, and how they can operate with other initiatives to promote socially just sustainable energy provision.

We would argue that a fundamental part of these efforts includes the need to re-examine the ways in which transitions towards sustainable energy provision can be achieved; and that this requires a reframing of the ways in which the challenges are understood and acted upon. As the introduction to a previous special issue (SI) in this journal observed [4], energy provision is a field dominated by the disciplines of engineering and economics, and is thus preoccupied with the financial and technical dimensions of the challenge. The door is wide open, therefore, for critical social science voices to join the debate. Doing so may help us avoid the traps of technological determinism implicit in much engineering and economics based analyses. In particular, there is a need to attend to the neglected socio-cultural and political dimensions of sustainable energy provision.

The aforementioned SI – "Renewable Energy in Sub-Saharan Africa: Contributions from the Social Sciences" (Vol. 5) – covered a range of energy issues and technologies, setting out a broad agenda for social scientists conducting research on renewable energy in Africa [4]. It made an important contribution across multiple areas; a contribution that, in this SI, we seek to build upon and extend in two ways. First, the current SI focuses predominantly on photovoltaics (solar PV) in Africa as opposed to renewable energy in general. This is warranted by the astonishing pace and scale at which solar PV is diffusing across the African continent, together with a plethora of new business models and an increasing emphasis (especially by donors) on the private sector and "entrepreneurs" as key actors for driving this change [5, 6, 7]. A core aim of this SI is therefore to explore, from critical social science perspectives, the dimensions and driving forces of this particular "socio-technical transition".

Second, and perhaps more critically, we seek to draw a marker in the sand of social science research in the field of sustainable energy research in Africa and beyond. In particular, we emphasise, and demonstrate the value of, work that focusses on the socio-cultural and political dimensions of energy access. This does not mean we neglect technology or finance; these dimensions are addressed in all the contributions. The perspectives showcased here, however, position technology and finance within broader socio-cultural and political realities that, as the papers demonstrate, often fundamentally determine the success of energy access initiatives. Some papers focus directly on the social or political; in many, these considerations are operationalized via more sophisticated understandings of innovation and broader processes of socio-technical change.

Furthermore, a focus on the socio-cultural and political dynamics of energy access connects this SI's contributions with critical social science scholarship on sustainability more broadly. This includes contemporary engagement with ideas of "sustainability transformations" [8] and socially-just sustainable development [9], as well as the push-back against managerialist concepts such as the "nexus" (e.g. between energy, water, food, climate, etc.) [10]. It also intersects with critical accounts of financialisation and accumulation in the context of sustainability transformations [e.g. 11, 12], and the increasing neoliberalisation of development policy and practice [13]. Each of the 13 papers in this SI develops empirically-grounded analysis and argument, providing important insights in their own right. But, together, they constitute a diverse collection of voices, cases, conceptual tools and methodological techniques. We hope this plurality of perspectives, alongside other critical social science work now emerging in the field (reviewed further below), opens up energy-access debates by stimulating new thinking and new directions in research, policy and practice.

In the next section, after discussing the relevance of focussing on solar PV in Africa, we position this SI within the emerging social science literature on sustainable energy access. In section 3, we discuss some methodological aspects of the SI, including reflections on the process of convening the set of papers, noteworthy methodological innovations in regard to the energy access literature, and the geographical coverage of the SI's papers. We then summarise the contributions made by the papers before ending with some conclusions, including the SI's relevance to policy and practice.

2. Solar PV, Africa and the socio-cultural turn in energy research

Across Africa, market forces are working to complement or replace the role of state and donor agencies in supporting solar PV, previously considered a 'niche' technology [14, 15, 16]. Investment is occurring at multiple scales, from pico-solar products and solar home systems (SHSs), to mini-grids, village-based charging stations and large-scale multi-megawatt on-grid PV installations [6]. These trends are, however, manifesting unevenly across political and economic boundaries. While several authors point to the central importance of understanding the political and socio-cultural dimensions to the technological transition taking place across developing countries, few authors have explored these aspects in empirical depth. Indeed, as we noted above, the wider topic of sustainable energy has been predominantly analysed from the perspectives of technological change/innovations and economic feasibility studies, within a field dominated by the disciplines of economics and engineering. This two-dimensional "technology-finance" perspective has resulted in a "scholarly deficit" [15] in research on solar PV, and sustainable energy in developing countries more broadly, despite the increasingly high-profile international policy attention to the sustainable energy agenda (e.g. the UN's SE4All commitment and the Sustainable Development Goal, SDG7). Equally, it is useful to reflect on the relationship between cultural, political and social transitions themselves, and how these, in turn, shape, steer and drive market forces and the transition to solar PV technology.

Some recent work on sustainable energy has witnessed the beginnings of a "socio-cultural turn" [15]. A small number of contributions, including a handful from the previous ERSS SI on renewable energy in Africa, operationalize theoretical insights from social anthropology [17, 18, 19, 20, 21, 22], socio-technical transitions [16, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32], and common-pool resource management perspectives [33], and there is a growing (albeit arguably still too small) literature on the gender dimensions of energy and development [e.g. 34, 35, 36]. Work on the

political aspects, however, is almost non-existent, save for a handful of contributions dealing with energy, climate change and development more broadly [37, 38, 39, 40, 41, 42, but see 43].

A gap thus exists in understanding the political and socio-cultural dimensions to this rapidly unfolding transition. Detailed analyses can provide insights into the importance and implications of these neglected dimensions in the process of creating or facilitating markets for small-scale PV; in adopting certain policy instruments; in initiating, designing, negotiating and constructing large-scale PV projects; and, crucially, in seeking to understand the extent to which poor and marginalised women and men will gain or lose from these different pathways [c.f. 9] to electrification. As such, this SI seeks to explore some of the fundamental development implications of new markets and technology diffusion: e.g. capacity strengthening and the industrial spill-over effects of the transition to solar PV; or the ways in which the increased emphasis on neoliberal market-based interventions and entrepreneurialism privileges the interests of some actors over others, with material implications for the poor and marginalised. Such analysis is also important as the transition to sustainable energy access is highly uneven across different countries and varies sharply within countries, across urban and rural contexts, and between high and low-income communities [44, 45].

3. Methodologies

Here, we point to two noteworthy methodological innovations presented in this SI before discussing the geographical coverage of the papers. We then describe and reflect upon the process for selecting the SI's papers, including a few thoughts on what could explain the under-representation of African authorship, in the final selection.

3.1. Methodological innovations in this special issue

Similar to this journal's earlier SI on renewable energy in Africa, the papers here operationalize mostly qualitative research techniques, often with a focus on in-depth case studies. Two observations are, however, particularly noteworthy. The first is the emergence of the application of ethnographic research methods, adding to a small number of "energy ethnographies" such as those in another recent ERSS SI on energy and ethics [46], on sustainable energy access in India [47], and the energy metabolism of a Gambian village [48]. The ethnographies presented in several of the papers in this current SI give prominence to social constructions of the everyday lived realities of the poor and marginalised; those "passive" actors who are often uncritically assumed to benefit from the interventions and policies debated by energy and development analysts and academics. Perhaps unsurprisingly, as will become clear below, this ethnographic focus is coupled with the application of more critical theoretical perspectives, such as social practice theory, and those from the field of science and technology studies (STS).

The second methodological observation refers to the application of action research techniques. These are mostly by the same authors who, based on similar action research, contributed to the earlier SI on renewable energy in Africa. In particular, Ulsrud and Winther, and Winther et al, operationalize such an approach, demonstrating ways in which it is possible to conduct critical social science research in the energy and development field, whilst also being practitioners and agents of change.

3.2. Geographic coverage of the papers

It is worth pausing briefly to note this SI's physical geographic coverage across Africa. The original call for papers was open to work about anywhere in Africa. Yet, as illustrated in Table 1, the result is a collection of papers heavily skewed towards East Africa: Kenya dominates, and North and Southern African countries are not represented at all (except in Batchelor et al's paper which presents a meta-analysis of the whole of Africa).

Table 1: Representation of African countries as case studies within this SI

Country	Number of case studies in this SI
Kenya	9

Tanzania	1
Rwanda	2
Uganda	1
Malawi	1
Ghana	1
Senegal	2

This suggests a need for critical reflection on why this bias exists and the need to address this in future research. Kenya is a fascinating place to study solar PV, with one of the most successful per capita markets for off-grid solar in the world [15]. It is increasingly embracing neoliberal ideals, providing a fertile context to study, for example, the emergence of pay-as-you-go (PAYG) business models and the implications of neoliberal development approaches in the sustainable energy access space. Nevertheless, it is concerning if research is not emerging that focusses elsewhere. Without it, we will miss the socio-cultural and political specificities of sustainable energy access that vary significantly across multiple national and intra-national contexts.

3.3. Positionality and bias amongst authors and editors

As well as the need to address bias in the geographic focus of the papers herein, it is also important to acknowledge the relative lack of African authors or editors [c.f. 49, 50], despite an open call for abstracts, advertised through what, to many readers, will be considered the "usual" networks in energy and development research and complemented with some direct solicitations. Whilst we cannot provide definitive explanations for the under-representation of African authorship in this SI, we would suggest that the selection of papers is an artefact of a complex set of issues, not all of which we ourselves can identify. Nevertheless, we can attempt to offer speculative thoughts on what some of these issues may be.

The first, and in hindsight obvious, issue is our failure to include a scholar from an African institution as one of the guest editors; something that demands reflection and learning, and something that could be easily remedied in any future SI convenorship. The idea for this SI emerged organically out of discussions we had during various other collaborative activities in which we have been engaged. From this standpoint, the editorial team was assumed rather than reflected upon. Second, the critical social science field related to energy and development in Africa is possibly small, and so the potential for eliciting the work of African scholars may be constrained. Third, we would anticipate the initial reach of the open call to be a factor. Not all those working in energy and development, wherever they are, would necessarily have seen the call, perhaps for reasons, amongst others, of technical or social connectivity (e.g. not being part of the professional networks we used). Fourth, the need for papers written in English is itself exclusionary, creating a bias towards Anglophone Africa. Fifth, not all those with interesting insights about energy and development are able to access the funding required to conduct research and write academic papers, even if they have the time and inclination to do so. Moreover, the overwhelming bulk of funding for research in Africa is targeted at agriculture and health, alongside a growing interest in funding science, technology, engineering and mathematics topics [50, 51]. We might surmise from this that even where research on sustainable energy access is being funded, much of it may be steered towards engineering and economics. For this SI, we requested specifically for papers that were not focussed exclusively on the engineering and economics of solar PV in Africa. Finally, our editorial decisions may have been affected by biases we are unable even to notice. For example (amongst others), although we have all worked as analysts and practitioners in energy and development in SSA settings, as Europeans, we have been trained in particular understandings and inevitably interpret sustainable energy challenges in Africa in particular ways, potentially conflicting with what African scholars would consider important. Each of these raises questions about equity in academia and the institutions necessary for enabling a plurality of voices to be heard, with implications for funding, social science systems in Africa (and elsewhere), and other issues of equity across "the academy". As we noted above, we are unable to answer these questions but they deserve serious research and attention.

4. Contributions of papers in this special issue

In this final section, we focus on summarising the various contributions of this SI's papers, with particular emphasis on the emergence of theoretical perspectives that have not been applied before (or applied in only a small number of cases) to the analysis of sustainable energy access.

4.1. Systems thinking

A significant recent move within the energy access literature has been the introduction of innovation systems thinking. This field emerged originally from attempts by innovation studies scholars to address the failure of neo-classical economics to account for the role of innovation in economic growth, developing into the National Innovation System concept [52]. Subsequent work has created related but different innovation system concepts: e.g. technology (TIS), regional (RIS) or sectoral innovation systems (SIS) [53]. Recent work argues that innovation systems thinking has much to contribute in understanding energy access challenges in developing (and particularly low-income) countries, where innovation systems are often weak or non-existent, particularly around newer energy technologies such as solar PV [15, 54].

Several authors in this SI operationalize an innovation systems perspective, often integrated with other conceptual frameworks, such as socio-technical transitions, social practice theory, or both. Hansen et al.'s paper focusses solely on an innovation systems perspective. They apply SIS to analyse the differences in the development and organisation of markets for large and small-scale applications of wind and solar PV in Kenya. Importantly, they observe greater similarities between large-scale wind and solar, and between small-scale wind and solar, than between large and small-scale wind, or large and small-scale solar. This suggests the need to disaggregate within sectors on the basis of size when applying the SIS approach, with perhaps different innovation systems present within broadly defined sectors. Their analysis also emphasises how energy and development pathways, particularly in relation to inclusiveness and sustainability, can be impacted by choices around size rather than the energy technology itself: "The size choice is at the core as a defining element of alternative renewable electrification paradigms, regardless of whether electrification is achieved by harnessing the sun, wind or water flows." Similar to Lema et al. [55], they emphasise local technology production, using local services and labour for construction and maintenance, as being core to the inclusiveness of such paradigms, with implicit questions about who gains from different scales of electricity provision: e.g. remote rural communities versus grid-connected industrial interests.

4.2. System builders

As well as recognising the relevance of building innovation systems to improve access to solar PV (and other renewable energy technologies) in developing countries, recent work also emphasises the role key actors play in actually building these systems; actors who might be described as "innovation system builders" [15, 54]. In this regard, Pedersen and Nygaard present an incisive analysis of the institutional work of innovation system builders who are attempting to implement solar mini-grids in Kenya's PV niche. Here we see the efforts of these private sector niche actors to confront powerful regime actors in Kenya's electricity sector, and we see how, despite the electricity utility's recent unbundling, state actors continue to dominate the electricity "market". A particularly novel theoretical contribution of the paper is its demonstration of the "institutional work" conducted by system builders, highlighting, in particular, their "cognitive institutional work" (to enhance acceptance of mini-grid technologies) and their "normative institutional work" where they attempt to establish a shared world view between entrenched ex-state actors and the private-sector led off-grid model they are pursuing. Here issues of equity and social justice are brought to bear in a range of ways, including through discursive tropes [56] employed by private sector actors. For example, the term "we are all Kenyans", coined by the ex-state electricity monopoly, is used to argue for a universal electricity tariff. A universal tariff would disadvantage off-grid solutions, which are higher-cost when only the end-price paid per unit consumed is considered. But private sector system builders have turned the "we are all Kenyans" trope on its head, using it to argue they should therefore have the same access to subsidies as the ex-state-owned network infrastructure company so as to facilitate electricity access in areas of the country where grid access is prohibitively expensive.

As well as demonstrating this institutional work, Pedersen and Nygaard articulate the legal and economic barriers these system builders face in attempting to establish mini-grids in Kenya. Their paper, like several others in this SI, demonstrates the analytical traction possible from using a socio-technical transitions perspective. And it is an implicit demonstration of how efforts to achieve sustainable energy access are fundamentally political, where actors face resistance from entrenched interests and so must do political work ("institutional work" to use the authors' preferred term) to influence and overcome this resistance.

4.3. Socio-technical perspectives

Many of the papers in this SI draw on socio-technical transitions concepts, especially the multi-level perspective (MLP) [57] and strategic niche management [58]. Whilst this is a burgeoning field, it is only recently that its applicability and evolution in the context of developing countries has emerged, including a recent special issue on the topic [see 59, 60]. Its application to the issue of sustainable energy access is more recent still, with a couple of early examples from 2011 and a more recent run of papers building momentum around this specific application of socio-technical transitions theory [15, 16, 23, 24, 25, 26, 27, 28, 42, 54, 61]. In essence, a socio-technical understanding of sustainable energy access reveals how technologies and their use within society co-evolve, often leading to lock-in and path dependency. Niches of new technology-use, such as for off-grid solar PV, provide spaces within which to learn how the niche-technology can compete with existing regimes of energy supply and use (e.g. kerosene-use and related cultural practices around cooking and lighting, and the entrenched interests involved in kerosene-supply). The MLP also conceptualises "landscape" pressures beyond regimes, which can exert broader pressures that might lead to change. It is this focus on understanding how change towards more sustainable transitions might be achieved that is at the root of most socio-technical transitions-inspired analysis.

In this SI, contributions variously add to the emerging body of work that applies socio-technical transitions to understanding sustainable energy access in the Global South. We have already discussed the paper by Pedersen and Nygaard, who use the MLP to position their deeper analysis. But other papers, reviewed in more detail below, also apply socio-technical transitions perspectives. Rodríguez-Manotas et al. operationalize an MLP perspective to analyse the construction in Rwanda of the largest on-grid solar PV plant in SSA; Byrne et al. integrate strategic niche management with political economy perspectives to analyse off-grid solar PV in Kenya; Ulsrud et al. fuse insights from socio-technical-inspired perspectives and social practice approaches to analyse village-level solar PV in Kenya; and Davies analyses socio-technical arrangements through three different "market devices" in Kenya, Uganda and Malawi.

Each paper tends to use the MLP or strategic niche management as a broad organising framework, which then allows the application of additional conceptual perspectives for more focussed considerations germane to analysing solar PV and sustainable energy access within the African countries of interest. This is characteristic of other contributions that intersect with work on energy access in Africa – e.g. analysis by Newell and Phillips [40] of the political economy of energy transitions in Kenya – implying that many scholars find socio-technical transitions frameworks useful at a framing level, but find them in need of more nuanced and detailed conceptual tools in order to understand how sustainable energy access and inclusive development is, is not, or might be achieved.

4.4. Social practice

A potentially ground-breaking contribution of this SI is to showcase the analytical relevance of a social practice-based approach to understanding energy access in developing countries. Social practice theory has been developed by scholars such as Shove and Walker [e.g. 62, 63, 64] for understanding energy and energy demand in industrialised countries, building on seminal works by Schatzki [65, 66, 67]. The analytical purchase of social practice theory rests on asking the question "what is energy for" [as Shove and Walker put it, 62]. It recognises that people do not want energy; rather, they want to read, or cook, stay healthy, or to communicate, all of which are facilitated by energy. Whilst some past work has alluded to the potential importance of

a social practice perspective in the context of sustainable energy access [15], and arguably socio-technical transitions perspectives operationalize aspects of it, particularly through early engagement with Giddens' [68] ideas, three papers in this SI apply it explicitly to analyse sustainable energy access, and one paper rests an important aspect of its argument on the concept of social practice.

In their paper, Boamah and Rothfuß study the use of SHSs in Ghana by what they describe as "a new energy elite". They demonstrate how those in this social group have adapted their social practices to the availability and use of decentralized solar as a strategy to counter the unreliability and perceived expense of grid-based electricity. This, they emphasise, does not belittle the role of finance or technological availability, but their analysis reveals the social practices of technology users as an additional dimension, which is equally relevant to understanding why and how solar technologies are adopted. In the case of Ghana, it was the new social practices that evolved through grid-based electricity – for example, watching TV, refrigerating food and drink, illuminating more rooms for longer – that this new energy elite adapted to SHS-based electricity once grid-based electricity became less reliable and more expensive.

The second paper using a social practice approach is Ulsrud et al.'s, where they combine it with socio-technical and innovation systems perspectives to analyse village-level solar interventions in India, Senegal and Kenya. They emphasise how:

> "Social practice theory provides important insights on this interrelationship due to the repetitive character of energy provision and use and the way material and socio-cultural structures such as local knowledge, ideas of progress, norms and values shape what people do with energy … Energy practices may in turn influence the operational and economic sustainability of the electricity provision and the qualities of the electricity services."

From this perspective they ask the question; "What happened when the hopeful visions [of village-level solar electrification project implementers] and socio-technical designs met social realities?" This highlights how the technical eventually meets the social, which is fundamental to the success of the technical.

Similar to Hansen et al., Ulsrud et al. also attend to scale, choosing to focus on village-scale electrification, including mini-grids, energy charging centres and other small-scale solar applications in villages. They argue this is necessary to understand the different types of knowledge, policies and support that are required at this scale of solar application in contrast to individual standalone systems, or to centralized grid-connected electricity supply. They also argue that village-level systems are important for increasing the range of electricity services available to communities, overcoming the need for individual equipment investment and maintenance, and providing opportunities for more power-demanding equipment (with implications for how electricity access facilitates economic activity [e.g. see 69, 70]). Similarly to Pedersen and Nygaard, they acknowledge the importance of a supportive regulatory environment for the success of village level electrification projects although, interestingly, they report positively on this in relation to Kenya (conflicting with Pedersen and Nygaard's findings) whilst identifying regulatory barriers in Senegal. But in both Kenya and Senegal, Ulsrud et al. argue that the limited ability of poor people to pay for electricity services is prohibitive to flexible design and implementation of village-level electrification projects, having observed that flexibility in project planning and implementation is a key criterion of success.

The third paper in this SI to use a social practice approach is Winther and Ulsrud, who analyse the gendered dimensions of electricity access. They examine how solar-powered access to electricity at two different sites in Kenya contributes, or not, to women's empowerment. Based on Shove's work [71], they examine different systems of solar-powered provision and types of end users within specific socio-cultural contexts, focussing on who is and is not able to obtain access to energy services. They show "…that the issue of access is not only, or even mainly, a question of technology, but about ideas about users, processes of implementation and organization of supply, and end-users' needs, social positions and aspirations."

In support of this finding, Winther and Ulsrud provide a detailed account of the various ways that different modes of provision empower or subjugate women. For example, we see how, for household-based solar systems, women are often subjugated in decision-making processes, with choices made by the male head of the household to prioritise lights in bathrooms and

bedrooms but not kitchens. This is in line with earlier research by Jacobson in Kenya [72], and Kumar finds similar gendered access in Bihar in India [47]. The intersection between availability of electric light and levels of domestic violence is also brought to the fore, where general access to light in the home may reduce incidences of domestic violence, even if women do not benefit in other ways from electricity access, such as in the kitchen.

The paper also reports on an action research project in which the authors have been involved, where a village energy centre was established and deliberately staffed by women who were trained in India to assemble and maintain solar systems. As well as observing how the flexible renting and recharging of lanterns from the energy centre provided women in the village with more autonomy over decisions as to where electric light is used, Winther and Ulsrud demonstrate how the women-targeted approach has had broader implications for women's empowerment in the village. Social norms began to be challenged as men expressed surprise and respect for the women and their ability to provide electricity services – an impact that the authors suggest may be amplified by the perception of electricity as modernity. Thus, the authors recommend that policy makers and practitioners move urgently to mainstream the integration of women in the planning, management and operation of energy programmes and projects.

In addition to these three papers that use practice theory, Batchelor et al. consider the potential for solar-powered cooking in Africa, emphasising the requirement for meaningful analysis to begin with understanding the social practices that sustainable energy technologies are assumed to facilitate. Whilst they do not draw from the social practice literature, they are heavily critical of existing investment in improved cook stoves due to the tendency to focus on "…the mechanisms to distribute new and supposedly improved technology, rather than understanding the cooking practices of those being encouraged to adopt it." They argue this is critical because, as a direct consequence of this failure to begin with an understanding of cooking practices, "…access to cleaner cooking solutions alone is clearly not translating into sustained new patterns of cooking."

The paper is interesting for two other reasons. First, it uses future-casting in building a case for the role that solar cooking can and (they imply) will play in Africa. Second, and perhaps more interesting, is that the authors are happy to advocate strongly for their position. For example: "We state clearly - what was once seen as an unrealistic dream just a few years ago, could in fact be a game changer in the very near future, bringing modern cooking infrastructure and energy to all." And later in the paper: "This paper forms part of a broader programme of work that began with Batchelor's (2013) proposition that by 2020, the monthly cost of cooking on a solar home system would be comparable with current expenditures on charcoal." Whilst some readers might baulk at such bold statements and advocacy which stray from the academic norm, the approach is transparent in regard to the positionality of the researchers and acknowledges their own personal interests, as well as providing a clear position statement for policy makers and practitioners.

4.5. Politics and political economy

Another key contribution of several papers in this SI (implicitly and explicitly) is a focus on the politics and broader political economy of sustainable energy access in Africa. Rodríguez-Manotas et al.'s paper examines the politics of energy transitions. Using the MLP from the socio-technical transitions literature, the paper focusses on issues of agency and politics in the construction in Rwanda of the largest grid-connected solar project in SSA. In line with other recent political economy analyses of energy transitions in SSA [e.g. 40, 42, 73], they analyse competing development visions, material interests, the power of capitalist institutions in setting the terms of transitions, and what this means for distributional politics:

> "Transitions are not neutral processes but entail 'social', 'material' and the 'political'…, and the actors driving the processes have vested interests and varying levels of power. Further, this power is not concentrated at a particular level (e.g. niche or regime) or within specific actors, but differing degrees of power is dispersed across a number of actors at numerous levels... This also relates to the politics of sustainable development and the politics of science and technology at large..."

The story this enables them to tell is of the coalescing of multiple different interests and visions, in a project that was ultimately fast-tracked due to strong top-down approval and "aggressive leadership" at the highest levels of government. Whilst we might be tempted to take such strong leadership as a positive force in facilitating low carbon energy transitions, the authors are cautious about whether this will underpin a wider sustainable energy transition or whether it is "…a bubble of a nascent industry, lured by profits, low risk [because of government guarantees], and the social currency of clean energy", and the extent to which it aligns with more progressive ideas of transitions or "transformations" that place democracy, free-speech and plural development pathways at the core of meaningful positive futures [74]. Either way, Rodríguez-Manotas et al.'s paper demonstrates how politics and power (in the political-interest sense) are fundamental to the nature and achievement of clean energy transitions.

Byrne et al.'s paper also places the political centre stage, this time with a focus on the broader political economy dynamics of solar PV in Kenya. Like Rodríguez-Manotas et al., they integrate this focus with a socio-technical transitions perspective, but do so using strategic niche management theory. They revisit their previous research on the success of the solar PV market in Kenya [15] that, based predominantly on a combination of innovation systems and strategic niche management, was weak in its treatment of politics. In this new paper, responding to their own concerns and those of scholars such as Kern [75], they present a means of integrating a political economy perspective with strategic niche management. As well as this theoretical contribution, the paper exposes fundamental tensions between the developmentalist interventions, which (as their earlier work demonstrated) provided the basis for the success of the solar PV market in Kenya to date, and the neoliberal orthodoxy that dominates global agreements and donor investments at present. Interestingly, they also show how pioneers in the solar PV space in Kenya adopted neoliberal "market failure" language in order to leverage donor funding. These pioneers then used this to fund activities that resemble developmental interventions, rather than the kinds of entrepreneurial and private sector activities that the neoliberal development discourse currently assumes holds the answers to sustainable energy access and other SDGs [see also 5]. In other words, neoliberal rhetoric was used to leverage developmental action, and it was these developmental activities that underpinned the widely acclaimed success of the off-grid solar PV market in Kenya, contrary to the claims of many analysts who credit Kenya's solar PV success to its embrace of free-market orthodoxy.

Whilst Rodríguez-Manotas et al. and Byrne et al.'s papers are the most explicit in their engagement with politics, other papers in the SI also engage with the political, both implicitly and explicitly. For example, Pedersen and Nygaard's demonstration of the "institutional work" that private sector solar mini-grid niche actors are undertaking in Kenya is also an illustration of how political work is fundamental to sustainable energy transitions. Here, we see work that involves, for example, lobbying for regulatory change, building relationships with regime actors to effect such lobbying, constructing normative discourses of how mini-grids fit with national electrification visions. It is difficult to argue that such work is not political. Similar observations might be made, for example, of the exclusive material impacts of alternative framings of energy access (Simmet's paper), solar "waste" disposal (Cross and Murray), or market devices (Davies), each of which is reviewed below, or the issues pertaining to gender and women's empowerment that Winther et al.'s paper examines. This emphasis on politics is not new, either in relation to energy access [e.g. 39, 43], or socio-technical transitions research [e.g. 76, 77], but it is, arguably, under-represented in energy access scholarship and serves to emphasise how critical it is to understand politics if we are to understand who gains, who loses, how and why from the different approaches to policy and practice that are currently playing out around energy access, with billions of dollars being spent [78].

4.6. Critical perspectives on the framing of energy access

Finally, a key contribution made by papers in this SI involves a critique of the ways in which aspects of sustainable energy access and broader energy transitions in Africa are framed, and the material implications of this in further marginalising or excluding the already-marginalised voices of poor countries and poor women and men therein. These papers present detailed, empirically-grounded explorations of the ways in which such framings are playing out in Africa.

Arguably, they are critiques that all of us working in this field need to reflect upon and take seriously – whether we are researchers, policy makers or practitioners – if we are to avoid the unconscious bias and negative consequences that arise from our failure to properly acknowledge our own positionalities and constructions of the "problems" around energy and development that we seek to "solve".

In their paper, Cross and Murray present an analysis of the framing of "solar waste" – an issue that has gone largely un-researched until now, despite the significant amount of material that results from solar components and systems once they break down. The authors' research responds to the way in which this problem was framed in a recent report commissioned by DfID, a report that Cross and Murray claim is pivotal for the off-grid solar PV industry. Their core argument rests on the fact that, as they say, "The problem… is no longer that no one is talking about solar waste. The problem today is how solar waste is being discussed, in what terms, and by whom." Based on detailed ethnographic work in Kenya, they show how the current framing of the issue as "solar waste" ignores the significant, established economies of repair and end-use that exist for these materials "… as they move through homes, repair centres and office workshops" where specific parts and components simultaneously move through different "regimes of value" that are ignored by the idea of "solar waste". As such, they argue we need to account for more than just the tonnage of "waste" and the financial value of recycled materials, as the DfID report does. Rather, following other scholars in the field of "discard studies", we should examine the multiple "afterlives" of solar, not the singular "end-of-life".

Building on traditions in critical geography and anthropology, they take this critique further still, positioning it within a broader understanding of justice, capital accumulation and the politics of work and labour. They direct our attention towards currently ignored sites of value, where local actors are engaged in the afterlives of solar components, as well as beyond this to the broader supply chains of solar, posing questions about the extent to which even ideas of distributive justice can go far enough, failing, as they do, "…to address the politics of work and labour across sites of mining, sourcing, assembly, and manufacturing... Meanwhile, the addition of batteries, broken circuit boards, plastic casings and photovoltaic modules to electronic waste flows pose new questions about whether or how the work of disposal will disproportionately distribute risk."

Davies' paper shares some common ground with Cross and Murray in the way in which it shines a light on how the marketisation of low-carbon household energy products in SSA is increasingly resulting in (political) power asymmetries between international "macro" level actors and local artisans and other local actors who might otherwise derive some value from an emerging market in low-carbon energy products. Davies draws on critiques of marketization, particularly that of Caliskan and Callon, but also drawing on concepts developed by Foucault, MacKenzie, and Callon and Latour. This positions the paper (together with Simmet's paper reviewed below) as only the second time in the energy and development literature – as far as we know – that an STS-inspired critique has been operationalized. Based on detailed ethnographic research in Kenya, Uganda and Malawi, Davies' analysis demonstrates how even the most seemingly benign market devices can serve to reinforce and deepen existing inequalities between market actors at the international and local levels (e.g. local sellers of solar lanterns and local consumers of these lanterns). Warranties written in English, which is often not understood, are shown to be unworkable. There is often no system for the warranty to be fulfilled: e.g. lack of receipts proving time of purchase, international exporters only replacing whole products, thus reducing the potential for local learning and capacity building around replacing specific failed components. Moreover, the anticipated cost of honouring warranties is still passed on to the consumer.

Even in relation to product standardization and certification, for which there has been a huge push in the solar lantern market in Africa in recent years (with the rationale of protecting the interests of consumers), Davies' analysis demonstrates how these market devices can serve to further marginalize local actors who lack the technical expertise and laboratories necessary for testing and certifying products. Indeed, as such devices are designed by international companies, who do have access to technical expertise and testing facilities, the devices serve also to increase the power and enhance the interests of these international players. Overall, Davies' analysis leaves us with a clear picture both of the ways in which market devices can increase the complexities of

the provision of energy services and how this reinforces power asymmetries and unequal access in favour of large international actors.

This kind of power asymmetry between the international and the local is also demonstrated by Simmet's critical analysis of the way in which different visions of energy transitions in Africa act to marginalize local voices. Similar to Cloke et al. [79], Simmet operationalizes the STS idea of "socio-technical imaginaries". Based on ethnographic work in Senegal that examines alternative visions of energy transitions in the country amongst three different sets of actors, Simmet shows that an international technologically-deterministic imaginary dominates over a locally-focussed indigenously-driven one. This is critical, because the dominant international imaginary begins with technologies (solar modules) and assumes these will transform society, whereas the subordinated locally-focussed imaginaries begin with social conditions from which technologies assist the realisation of desirable futures. The result is that a particular vision of technologically-driven development, aligned with the interests of already-powerful international actors, is privileged while locally-situated visions are at best ignored if not actively marginalised [and see 9].

Simmet's analysis resonates with the emphasis of many of the other contributions to this SI, particularly those that explicitly focus on the political and social practice dimensions of the diffusion of sustainable energy technologies. These are fundamental observations around the exercise of power and how political-economic interests are served through different actors' approaches to solar PV for electrification and "development". They also demonstrate the theoretical traction of STS concepts such as sociotechnical imaginaries in critically analysing energy futures in the Global South.

5. Conclusion

We are confident that the articles gathered in this SI offer a robust challenge to the predominance of technologically-deterministic, mainstream thinking in energy and development research, engaging with a range of critical perspectives that offer more subtle insights into how universal and sustainable energy access can be achieved. That is, the insights provided in the articles offer ways of acting that can be more effective both from a physical perspective (i.e. people have improved access to energy services), as well as from perspectives of social justice, human development, gender equality, and so on. With contributions that take us from post-colonial critiques of the framing of energy access (Simmet; Devies) to the significance of material solar waste (Cross and Murray), we believe this SI will help to mark a critical point of departure for energy access research, one that makes meaningful inroads into a social science of energy access. From a purely academic perspective, this begins to addresses the "scholarly deficit" in the energy access literature[15]), including novel contributions with regard to the application of social practice theory (Boamah and Rothfuß; Ulsrud et al; Winther and Ulsrud). From a more practical perspective, we see that these critical approaches enable us to consider and take seriously the lived realities of the poor and marginalised women and men whom it is assumed stand to benefit from the rapid proliferation of interest and spending in this field. Communicating the significance of these non-technical issues should be a priority for actors operating at the interface of energy research, social science and energy policy advocacy. Surely, all of us engaged in work towards the global goal of sustainable energy for all can agree that privileging these marginalised interests and meeting the needs of poor women and men is fundamental to what we are all working towards?

References

[1] IEA, Energy Access Outlook 2017, International Energy Agency, Paris, 2017.
[2] D.G. Ockwell, Energy and economic growth: grounding our understanding in physical reality, Energy Policy 36(12) (2008) 4600-4604.
[3] World Bank, ESMAP, SE4All, State of Electricity Access Report 2017, World Bank, Energy Sector Management Assistance Program and Sustainable Energy for All, Washington DC, 2017.

[4] K.J. Hancock, The expanding horizon of renewable energy in sub-Saharan Africa: Leading research in the social sciences, Energy Research & Social Science 5 (2015) 1-8.
[5] D. Ockwell, Rob Byrne, Kevin Urama, Nicholas Ozor, Edith Kirumba, Adrian Ely, Sarah Becker, L. Gollwitzer, Debunking free market myths: Transforming pro-poor, sustainable energy access for climate compatible development, in: F. Nunan (Ed.), Making Climate Compatible Development Happen, Routledge, Abingdon, 2017.
[6] U.E. Hansen, M.B. Pedersen, I. Nygaard, Review of solar PV policies, interventions and diffusion in East Africa, Renewable and Sustainable Energy Reviews 46 (2015) 236-248.
[7] Dalberg Advisors, Lighting Global, Off-Grid Solar Market Trends Report 2018, Dalberg Advisors, Lighting Global, GOGLA and ESMAP, Washington, 2018.
[8] I. Scoones, M. Leach, P. Newell, The Politics of Green Transformations, Routledge, Abingdon, 2015.
[9] M. Leach, I. Scoones, A. Stirling, Dynamic Sustainabilities: Technology, Environment, Social Justice, Routledge, Abingdon, 2010.
[10] A. Stirling, Pluralising progress: From integrative transitions to transformative diversity, Environmental Innovation and Societal Transitions 1 (2011) 82–88.
[11] K. Polanyi, The Great Transformation: The Political and Economic Origins of our Time, Beacon Press, Boston, 1980 (1944).
[12] D. Harvey, A Brief History of Neoliberalism, Oxford Univ. Press, Oxford, 2005.
[13] B. Selwyn, The Global Development Crisis, Polity, Cambridge, 2014.
[14] M. Bazilian, I. Onyeji, M. Liebreich, I. MacGill, J. Chase, J. Shah, D. Gielen, D. Arent, D. Landfear, S. Zhengrong, Re-considering the economics of photovoltaic power, Renewable Energy 53 (2013) 329-338.
[15] D. Ockwell, R. Byrne, Sustainable Energy for All: Innovation, Technology and Pro-Poor Green Transformations, Routledge, Abingdon, 2016.
[16] P. Rolffs, D. Ockwell, R. Byrne, Beyond technology and finance: pay-as-you-go sustainable energy access and theories of social change, Environ Plann A 47(12) (2015) 2609-2627.
[17] T. Winther, The Impact of Electricity: Development, Desires and Dilemmas, Berghahn Books, Oxford, 2008.
[18] B. Campbell, J. Cloke, E. Brown, Communities of energy, Economic Anthropology 3(1) (2016) 133-144.
[19] B. Campbell, P. Sallis, Low-carbon yak cheese: transition to biogas in a Himalayan socio-technical niche, Interface Focus 3(1) (2013).
[20] J. Cross, The 100th object: Solar lighting technology and humanitarian goods, Journal of Material Culture 18(4) (2013) 367-387.
[21] J. Cross, Off the grid: Infrastructure and energy beyond the mains, in: Penny Harvey, Casper Bruun Jenson, Atsuro Morita (Eds.), Infrastructures and Social Complexity, Routledge, Abingdon, 2016.
[22] I. Nygaard, Institutional options for rural energy access: exploring the concept of the multifunctional platform in West Africa, Energy Policy 38(2) (2010) 1192–1201.
[23] H. Ahlborg, M. Sjöstedt, Small-scale hydropower in Africa: Socio-technical designs for renewable energy in Tanzanian villages, Energy Research & Social Science 5 (2015) 20-33.
[24] B.K. Sovacool, A.L. D'Agostino, M.J. Bambawale, The socio-technical barriers to Solar Home Systems (SHS) in Papua New Guinea: "Choosing pigs, prostitutes, and poker chips over panels", Energy Policy 39(3) (2011) 1532-1542.
[25] K. Ulsrud, T. Winther, D. Palit, H. Rohracher, J. Sandgren, The Solar Transitions research on solar mini-grids in India: Learning from local cases of innovative socio-technical systems, Energy for Sustainable Development 15(3) (2011) 293-303.
[26] K. Ulsrud, T. Winther, D. Palit, H. Rohracher, Village-level solar power in Africa: Accelerating access to electricity services through a socio-technical design in Kenya, Energy Research & Social Science 5 (2015) 34-44.
[27] U.E. Hansen, I. Nygaard, Sustainable energy transitions in emerging economies: The formation of a palm oil biomass waste-to-energy niche in Malaysia 1990–2011, Energy Policy 66 (2014) 666-676.
[28] I. Nygaard, U.E. Hansen, Niche development and upgrading in the PV value chain: The case of local assembly of PV panels in Senegal, EU-SPRI Conference Lund 2016, 2016.

[29] A. Tigabu, F. Berkhout, P. van Beukering, Development aid and the diffusion of technology: Improved cookstoves in Kenya and Rwanda, Energy Policy 102 (2017) 593-601.
[30] L.M. Kamp, L.F.I. Vanheule, Review of the small wind turbine sector in Kenya: Status and bottlenecks for growth, Renewable and Sustainable Energy Reviews 49 (2015) 470-480.
[31] I. Nygaard, S. Bolwig, The rise and fall of foreign private investment in the jatropha biofuel value chain in Ghana, Environmental Science & Policy (2017).
[32] H.A. Romijn, M.C.J. Caniëls, The Jatropha biofuels sector in Tanzania 2005–2009: Evolution towards sustainability?, Research Policy 40(4) (2011) 618-636.
[33] L. Gollwitzer, D. Ockwell, B. Muok, A. Ely, H. Ahlborg, Rethinking the sustainability and institutional governance of electricity access and mini-grids: Electricity as a common pool resource, Energy Research & Social Science 39(Supplement C) (2018) 152-161.
[34] S.E. Ryan, Rethinking gender and identity in energy studies, Energy Research & Social Science 1 (2014) 96-105.
[35] T. Winther, M.N. Matinga, K. Ulsrud, K. Standal, Women's empowerment through electricity access: scoping study and proposal for a framework of analysis, Journal of Development Effectiveness 9(3) (2017) 389-417.
[36] M. Marshall, D. Ockwell, R. Byrne, Sustainable Energy for All, or Sustainable Energy for Men? Gender and the construction of identity within climate technology entrepreneurship in Kenya, Progress in Development Studies 17(2) (2017) 1-25.
[37] W. Shen, M. Power, Africa and the export of China's clean energy revolution, Third World Quarterly (2016) 1-20.
[38] D. Tyfield, A. Ely, S. Geall, Low Carbon Innovation in China: From Overlooked Opportunities and Challenges to Transitions in Power Relations and Practices, Sustainable Development 23(4) (2015) 206-216.
[39] H. Ahlborg, Towards a conceptualization of power in energy transitions, Environmental Innovation and Societal Transitions (2017).
[40] P. Newell, J. Phillips, Neoliberal energy transitions in the South: Kenyan experiences, Geoforum 74 (2016) 39-48.
[41] L. Baker, The evolving role of finance in South Africa's renewable energy sector, Geoforum 64 (2015) 146-156.
[42] L. Baker, P. Newell, J. Phillips, The Political Economy of Energy Transitions: The Case of South Africa, New Political Economy 19(6) (2014) 791-818.
[43] B.K. Sovacool, The political economy of energy poverty: A review of key challenges, Energy for Sustainable Development 16(3) (2012) 272-282.
[44] C. Mitchell, The Political Economy of Sustainable Energy, Palgrave Macmillan, London, 2007.
[45] G. Bridge, S. Bouzarovski, M. Bradshaw, N. Eyre, Geographies of energy transition: Space, place and the low-carbon economy, Energy Policy 53 (2013) 331-340.
[46] J. Smith, M.M. High, Exploring the anthropology of energy: Ethnography, energy and ethics, Energy Research & Social Science 30 (2017) 1-6.
[47] A. Kumar, Justice and politics in energy access for education, livelihoods and health: How socio-cultural processes mediate the winners and losers, Energy Research & Social Science 40 (2018) 3-13.
[48] A. Schiffer, Empowered, excited, or disenfranchised? Unveiling issues of energy access inequality and resource dependency in The Gambia, Energy Research & Social Science 18 (2016) 50-61.
[49] J. Henrich, S.J. Heine, A. Norenzayan, Most people are not WEIRD, Nature 466 (2010) 29.
[50] A. Cherry, J. Haselip, G. RalphsIsabella, I. Wagner, Africa-Europe Research and Innovation Cooperation: Global Challenges, Bi-regional Responses, Palgrave, Cham, Switzerland, 2018.
[51] J. Chataway, C. Ochieng, R. Byrne, C. Daniels, C. Dobson, R. Hanlin, M. Hopkins, Case Studies of the Political Economy of Science Granting Councils in Sub-Saharan Africa, SPRU (Science Policy Research Unit) and ACTS (African Centre for Technology Studies), Science Granting Councils Initiative [https://sgciafrica.org/en-za/], 2017.
[52] C. Freeman, The National System of Innovation in Historical Perspective, Cambridge Journal of Economics 19 (1997) 5-24.

[53] B. Truffer, Challenges for Technological Innovation Systems research: Introduction to a debate, Environmental Innovation and Societal Transitions 16(Supplement C) (2015) 65-66.
[54] D. Ockwell, R. Byrne, Improving technology transfer through national systems of innovation: climate relevant innovation-system builders (CRIBs), Climate Policy (2015) 1-19.
[55] R. Lema, R. Hanlin, U.E. Hansen, C. Nzila, Renewable electrification and local capability formation: Linkages and interactive learning, Energy Policy (in press).
[56] D. Ockwell, Y. Rydin, Conflicting discourses of knowledge: Understanding the policy adoption of pro-burning knowledge claims in Cape York Peninsula, Australia, Environmental Politics 15(3) (2006) 379-398.
[57] F. Geels, Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study, Research Policy 31 (2002) 1257–1274.
[58] R. Kemp, J. Schot, R. Hoogma, Regime shifts to sustainability through processes of niche formation: the approach of strategic niche management., Technology Analysis and Strategic Management 10 (1998) 175–196.
[59] U.E. Hansen, I. Nygaard, H. Romijn, A. Wieczorek, L.M. Kamp, L. Klerkx, Sustainability transitions in developing countries: Stocktaking, new contributions and a research agenda, Environmental Science & Policy (2017).
[60] A.J. Wieczorek, Sustainability transitions in developing countries: Major insights and their implications for research and policy, Environmental Science & Policy (2017).
[61] R. Byrne, Learning drivers: Rural electrification regime building in Kenya and Tanzania, SPRU, University of Sussex, Brighton, 2011.
[62] E. Shove, G. Walker, What Is Energy For? Social Practice and Energy Demand, Theory, Culture & Society 31(5) (2014) 41-58.
[63] E. Shove, Putting practice into policy: reconfiguring questions of consumption and climate change, Contemporary Social Science 9(4) (2014) 415-429.
[64] E. Shove, Beyond the ABC: climate change policy and theories of social change, Environ Plann A 42 (2010) 1273 - 1285.
[65] T.R. Schatzki, The Site of the Social: A Philosophical Account of the Constitution of Social Life and Change, Pennsylvania State University Press, Pennsylvania, 2002.
[66] T.R. Schatzki, Materiality and social life, Nature and Culture 5(2) (2010) 123–149.
[67] T.R. Schatzki, Where the Action Is: On Large Social Phenomena such as Sociotechnical Regimes, Sustainable Practices Research Group Working Paper 1, University of Manchester, Manchester, 2011.
[68] A. Giddens, The Constitution of Society, Polity Press, Cambridge, 1984.
[69] C. Kirubi, A. Jacobson, D.M. Kammen, A. Mills, Community-Based Electric Micro-Grids Can Contribute to Rural Development: Evidence from Kenya, World Development 37(7) (2009) 1208-1221.
[70] P. Cook, Rural Electrification and Rural Development,, in: S. Bhattacharyya (Ed.), Rural Electrification Through Decentralised Off-Grid Systems in Developing Countries, Green Energy and Technology, Springer, London, 2013.
[71] E. Shove, Comfort, Cleanliness and Convenience: The Social Organization of Normality, Berg Publishers, Oxford and New York, 2003.
[72] A. Jacobson, Connective Power: Solar Electrification and Social Change in Kenya, University of California, Berkeley, 2004.
[73] M. Power, P. Newell, L. Baker, H. Bulkeley, J. Kirshner, A. Smith, The political economy of energy transitions in Mozambique and South Africa: The role of the Rising Powers, Energy Research & Social Science 17 (2016) 10-19.
[74] A. Stirling, Emancipating Transformations: From controlling 'the transition' to culturing plural radical progress, STEPS Working Paper 64, STEPS Centre, Brighton, 2014.
[75] F. Kern, Engaging with the politics, agency and structures in the technological innovation systems approach, Environmental Innovation and Societal Transitions 16 (2015) 67-69.
[76] M. Lawhon, J.T. Murphy, Socio-technical regimes and sustainability transitions: Insights from political ecology, Progress in Human Geography 36(3) (2012) 354-378.
[77] J. Meadowcroft, Engaging with the politics of sustainability transitions, Environmental Innovation and Societal Transitions 1(1) (2011) 70-75.

[78] D. Ockwell, P. Newell, S. Geall, R. Byrne, K. Mbeva, W. Shen, A. Ely, The Political Economy of State-led Energy Transformations: Lessons from Solar PV in Kenya and China, STEPS Working Paper 92, STEPS Centre, Brighton, 2017.
[79] J. Cloke, A. Mohr, E. Brown, Imagining renewable energy: Towards a Social Energy Systems approach to community renewable energy projects in the Global South, Energy Research & Social Science 31(Supplement C) (2017) 263-272.